

NODE=B117

 $\Delta(1920)$ 3/2⁺

$I(J^P) = \frac{3}{2}(\frac{3}{2}^+) \text{ Status: } ***$

Most of the results published before 1975 were last included in our 1982 edition, Physics Letters **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006).

The latest GWU analysis (ARNDT 06) finds no evidence for this resonance.

 $\Delta(1920)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1900 to 1970 (~1920) OUR ESTIMATE			
1900 ± 30	ANISOVICH	12A	DPWA Multichannel
1920 ± 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1868 ± 10	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2146 ± 32	SHRESTHA	12A	DPWA Multichannel
1990 ± 35	HORN	08A	DPWA Multichannel
2057 ± 1	PENNER	02C	DPWA Multichannel
1889 ± 100	VRANA	00	DPWA Multichannel
2014 ± 16	MANLEY	92	IPWA $\pi N \rightarrow \pi N & N\pi\pi$
1840 ± 40	CANDLIN	84	DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$
1955.0 ± 13.0	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
2065.0 ± 13.6	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
2065.0 ± 12.9	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$

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→ UNCHECKED ←

 $\Delta(1920)$ BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
180 to 300 (~260) OUR ESTIMATE			
310 ± 60	ANISOVICH	12A	DPWA Multichannel
300 ± 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
220 ± 80	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
400 ± 80	SHRESTHA	12A	DPWA Multichannel
330 ± 60	HORN	08A	DPWA Multichannel
525 ± 32	PENNER	02C	DPWA Multichannel
123 ± 53	VRANA	00	DPWA Multichannel
152 ± 55	MANLEY	92	IPWA $\pi N \rightarrow \pi N & N\pi\pi$
200 ± 40	CANDLIN	84	DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$
88.3 ± 35.0	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
62.0 ± 44.0	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$

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 $\Delta(1920)$ POLE POSITION

REAL PART VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1850 to 1950 (~1900) OUR ESTIMATE			
1890 ± 30	ANISOVICH	12A	DPWA Multichannel
1900	² HOEHLER	93	SPED $\pi N \rightarrow \pi N$
1900 ± 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2110	SHRESTHA	12A	DPWA Multichannel
1980 ⁺²⁵ ₋₄₅	HORN	08A	DPWA Multichannel
1880	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

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→ UNCHECKED ←

-2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
200 to 400 (≈ 300) OUR ESTIMATE			
300 \pm 60	ANISOVICH	12A	DPWA Multichannel
300 \pm 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
386	SHRESTHA	12A	DPWA Multichannel
310 \pm 40 60	HORN	08A	DPWA Multichannel
120	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

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NODE=B117IM
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 $\Delta(1920)$ ELASTIC POLE RESIDUE**MODULUS $|r|$**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
17 \pm 8	ANISOVICH	12A	DPWA Multichannel
24 \pm 4	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

NODE=B117220

NODE=B117RER
NODE=B117RER

PHASE θ

VALUE (°)	DOCUMENT ID	TECN	COMMENT
- 40 \pm 20	ANISOVICH	12A	DPWA Multichannel
- 150 \pm 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

NODE=B117IMR
NODE=B117IMR

 $\Delta(1920)$ INELASTIC POLE RESIDUE

The “normalized residue” is the residue divided by $\Gamma_{pole}/2$.

Normalized residue in $N\pi \rightarrow \Delta(1920) \rightarrow \Delta\eta$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
17 \pm 8	70 \pm 20	ANISOVICH	12A	DPWA Multichannel

NODE=B117240

NODE=B117240

NODE=B117RS1
NODE=B117RS1

Normalized residue in $N\pi \rightarrow \Delta(1920) \rightarrow \Sigma K$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
9 \pm 3	80 \pm 40	ANISOVICH	12A	DPWA Multichannel

NODE=B117RS2
NODE=B117RS2

Normalized residue in $N\pi \rightarrow \Delta(1920) \rightarrow \Delta\pi, P\text{-wave}$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
20 \pm 12	- 120 \pm 30	ANISOVICH	12A	DPWA Multichannel

NODE=B117RS3
NODE=B117RS3

Normalized residue in $N\pi \rightarrow \Delta(1920) \rightarrow \Delta\pi, F\text{-wave}$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
28 \pm 7	- 95 \pm 35	ANISOVICH	12A	DPWA Multichannel

NODE=B117RS4
NODE=B117RS4

 $\Delta(1920)$ DECAY MODES

The following branching fractions are our estimates, not fits or averages.

Mode	Fraction (Γ_i/Γ)
$\Gamma_1 N\pi$	5–20 %
$\Gamma_2 \Sigma K$	(2.14 \pm 0.30) %
$\Gamma_3 N\pi\pi$	
$\Gamma_4 \Delta(1232)\pi, P\text{-wave}$	
$\Gamma_5 \Delta(1232)\pi, F\text{-wave}$	
$\Gamma_6 N(1440)\pi, P\text{-wave}$	
$\Gamma_7 N(1535)\pi$	
$\Gamma_8 N a_0(980)$	
$\Gamma_9 \Delta(1232)\eta$	(15 \pm 8) %
$\Gamma_{10} N\gamma$	0.0–0.4 %
$\Gamma_{11} N\gamma, \text{ helicity}=1/2$	0.0–0.2 %
$\Gamma_{12} N\gamma, \text{ helicity}=3/2$	0.0–0.2 %

DESIG=1;OUR EST

DESIG=2

DESIG=7

DESIG=3

DESIG=11

DESIG=4

DESIG=8

DESIG=9

DESIG=10

DESIG=12;OUR EST

DESIG=5;OUR EST

DESIG=6;OUR EST

$\Delta(1920)$ BRANCHING RATIOS **$\Gamma(N\pi)/\Gamma_{\text{total}}$**

VALUE (%)

5 to 20 OUR ESTIMATE

	DOCUMENT ID	TECN	COMMENT
8±4	ANISOVICH	12A	DPWA Multichannel
20±5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
14±4	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$

• • • We do not use the following data for averages, fits, limits, etc. • • •

	DOCUMENT ID	TECN	COMMENT
16±4	SHRESTHA	12A	DPWA Multichannel
15±8	HORN	08A	DPWA Multichannel
15±1	PENNER	02C	DPWA Multichannel
5±4	VRANA	00	DPWA Multichannel
2±2	MANLEY	92	IPWA $\pi N \rightarrow \pi N & N\pi\pi$
24	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
18	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$

NODE=B117230

NODE=B117R1
NODE=B117R1
→ UNCHECKED ←

|

OCCUR=2

 $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1920) \rightarrow \Sigma K$

VALUE

-0.052±0.015

• • • We do not use the following data for averages, fits, limits, etc. • • •

-0.049

DOCUMENT ID

CANDLIN

84

DPWA

 $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

DOCUMENT ID

TECN

COMMENT

 $\pi^+ p \rightarrow \Sigma^+ K^+$

NODE=B117R2

NODE=B117R2

|

 $\Gamma(\Sigma K)/\Gamma_{\text{total}}$

VALUE (%)

2.14±0.30 OUR AVERAGE

4 ±2

2.1 ±0.3

DOCUMENT ID

ANISOVICH

12A

DPWA

 Γ_2/Γ

NODE=B117R7

NODE=B117R7

 $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1920) \rightarrow \Delta(1232)\pi, P\text{-wave}$

VALUE

• • • We do not use the following data for averages, fits, limits, etc. • • •

-0.13±0.04

DOCUMENT ID

MANLEY

92

IPWA

 $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$

NODE=B117R3

NODE=B117R3

|

 $\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{\text{total}}$

VALUE (%)

22±12

41± 3

• • • We do not use the following data for averages, fits, limits, etc. • • •

7± 5

DOCUMENT ID

ANISOVICH

12A

DPWA

 Γ_4/Γ

NODE=B117R5

NODE=B117R5

|

 $\Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}}$

VALUE (%)

45±20

DOCUMENT ID

ANISOVICH

12A

DPWA

 Γ_5/Γ

NODE=B117R04

NODE=B117R04

|

 $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1920) \rightarrow N(1440)\pi, P\text{-wave}$

VALUE

• • • We do not use the following data for averages, fits, limits, etc. • • •

+0.06±0.07

DOCUMENT ID

MANLEY

92

IPWA

 $(\Gamma_1\Gamma_6)^{1/2}/\Gamma$

NODE=B117R4

NODE=B117R4

|

 $\Gamma(N(1440)\pi, P\text{-wave})/\Gamma_{\text{total}}$

VALUE (%)

53±8

• • • We do not use the following data for averages, fits, limits, etc. • • •

<20

DOCUMENT ID

VRANA

00

DPWA

 Γ_6/Γ

NODE=B117R6

NODE=B117R6

|

 $\Gamma(N(1535)\pi)/\Gamma_{\text{total}}$

VALUE (%)

• • • We do not use the following data for averages, fits, limits, etc. • • •

6±4

DOCUMENT ID

HORN

08A

DPWA

 Γ_7/Γ

NODE=B117R01

NODE=B117R01

|

 $\Gamma(N\alpha_0(980))/\Gamma_{\text{total}}$

VALUE (%)

• • • We do not use the following data for averages, fits, limits, etc. • • •

4±2

DOCUMENT ID

HORN

08A

DPWA

 Γ_8/Γ

NODE=B117R02

NODE=B117R02

|

$\Gamma(\Delta(1232)\eta)/\Gamma_{\text{total}}$

VALUE (%)	DOCUMENT ID	TECN	COMMENT	Γ_9/Γ
15±8	ANISOVICH	12A	DPWA Multichannel	NODE=B117R03 NODE=B117R03
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10±5	HORN	08A	DPWA Multichannel	

 $\Delta(1920)$ PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics, G **33** 1 (2006).

 $\Delta(1920) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT	
0.130 ^{+0.030} _{-0.060}	ANISOVICH	12A	DPWA Multichannel	
0.040±0.014	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.051±0.010	SHRESTHA	12A	DPWA Multichannel	
0.022±0.008	HORN	08A	DPWA Multichannel	
-0.007	PENNER	02D	DPWA Multichannel	

 $\Delta(1920) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT	
-0.115 ^{+0.025} _{-0.050}	ANISOVICH	12A	DPWA Multichannel	
0.023±0.017	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.017±0.015	SHRESTHA	12A	DPWA Multichannel	
0.042±0.012	HORN	08A	DPWA Multichannel	
-0.001	PENNER	02D	DPWA Multichannel	

 $\Delta(1920)$ FOOTNOTES

¹ CHEW 80 reports two P_{33} resonances in this mass region. Problems with this analysis are discussed in section 2.1.11 of HOEHLER 83.

² See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

 $\Delta(1920)$ REFERENCES

For early references, see Physics Letters **111B** 1 (1982).

ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)	REFID=54041
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)	REFID=54862
HORN	08A	EPJ A38 173	I. Horn <i>et al.</i>	(CB-ELSA Collab.)	REFID=52706
Also		PRL 101 202002	I. Horn <i>et al.</i>	(CB-ELSA Collab.)	REFID=52567
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)	REFID=51535
PDG	06	JPG 33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)	REFID=51004
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)	REFID=49129
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)	REFID=49130
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)	REFID=47593
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)	REFID=43821
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP	REFID=41535
Also		PR D30 904	D.M. Manley <i>et al.</i>	(VPI)	REFID=30071
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP	REFID=41467
CANDLIN	84	NP B238 477	D.J. Candlin <i>et al.</i>	(EDIN, RAL, LOWC)	REFID=40339
HOEHLER	83	Landolt-Bornstein 1/9B2	G. Hohler	(KARLT)	REFID=31158
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)	REFID=41167
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)	REFID=30067
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)	REFID=30068
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP	REFID=31151
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP	REFID=30064
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP	REFID=40096
LIVANOS	80	Toronto Conf. 35	P. Livanos <i>et al.</i>	(SACL) IJP	REFID=30402
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP	REFID=30058
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP	REFID=30859